

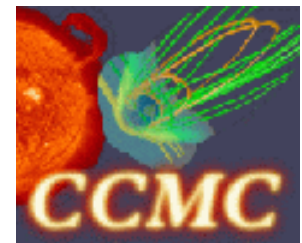
# Ionospheric Conductances and the Inner Magnetosphere

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# Motivation

Conductance of ionosphere strongly affects electrodynamics.  
Ionosphere is critical for dynamics of magnetosphere.

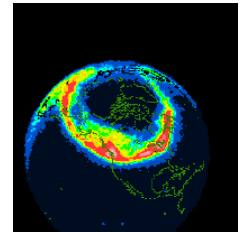
This study intends to:

Investigate impact of ionospheric conductances on

- field-aligned currents drawn from the magnetosphere
- electric field and potential patterns generated

Find new ways to improve current conductance models:

- increase robustness of results against variations of spatial resolution in magnetospheric part of simulation
- produce saturation of electric potentials as observed



# Study Conditions

IMF:  $B_y=0$ ,  $B_z=-5\text{nT}$

Solar wind:  $V_x=500\text{km/s}$ ,  $N=5/\text{cm}^3$

## 1. Conductance model comparison (at given resolution)

- ☐ different statistical models for conductances
- ☐ different constant conductances

Look at:

- effects on potentials, currents
- dependence of currents on average conductances

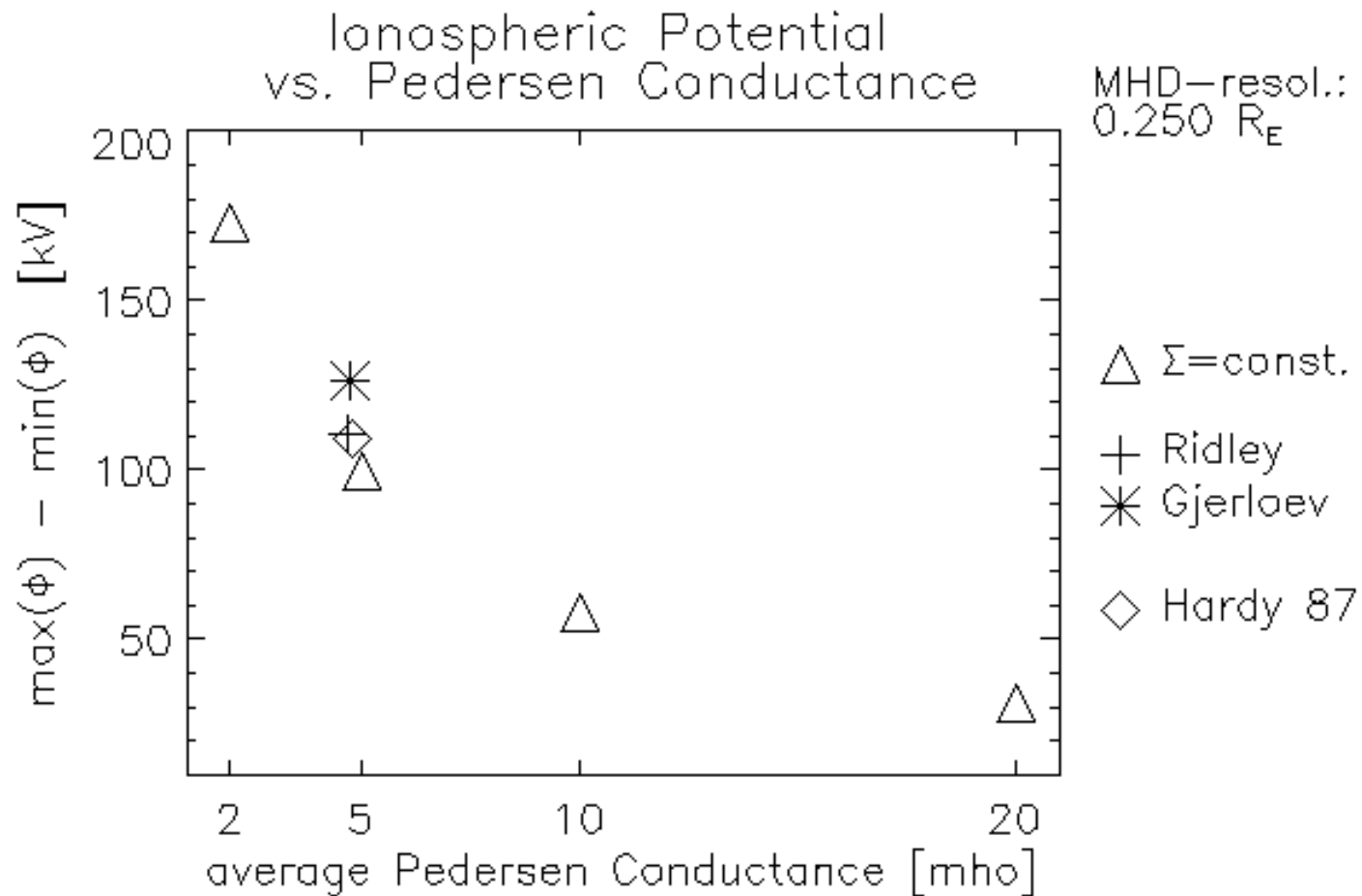
## 2. Spatial resolution study:

- ☐  $1/2, 1/4, 1/8 R_E$  resolution ( $1/16 R_E$  planned)

Look at:

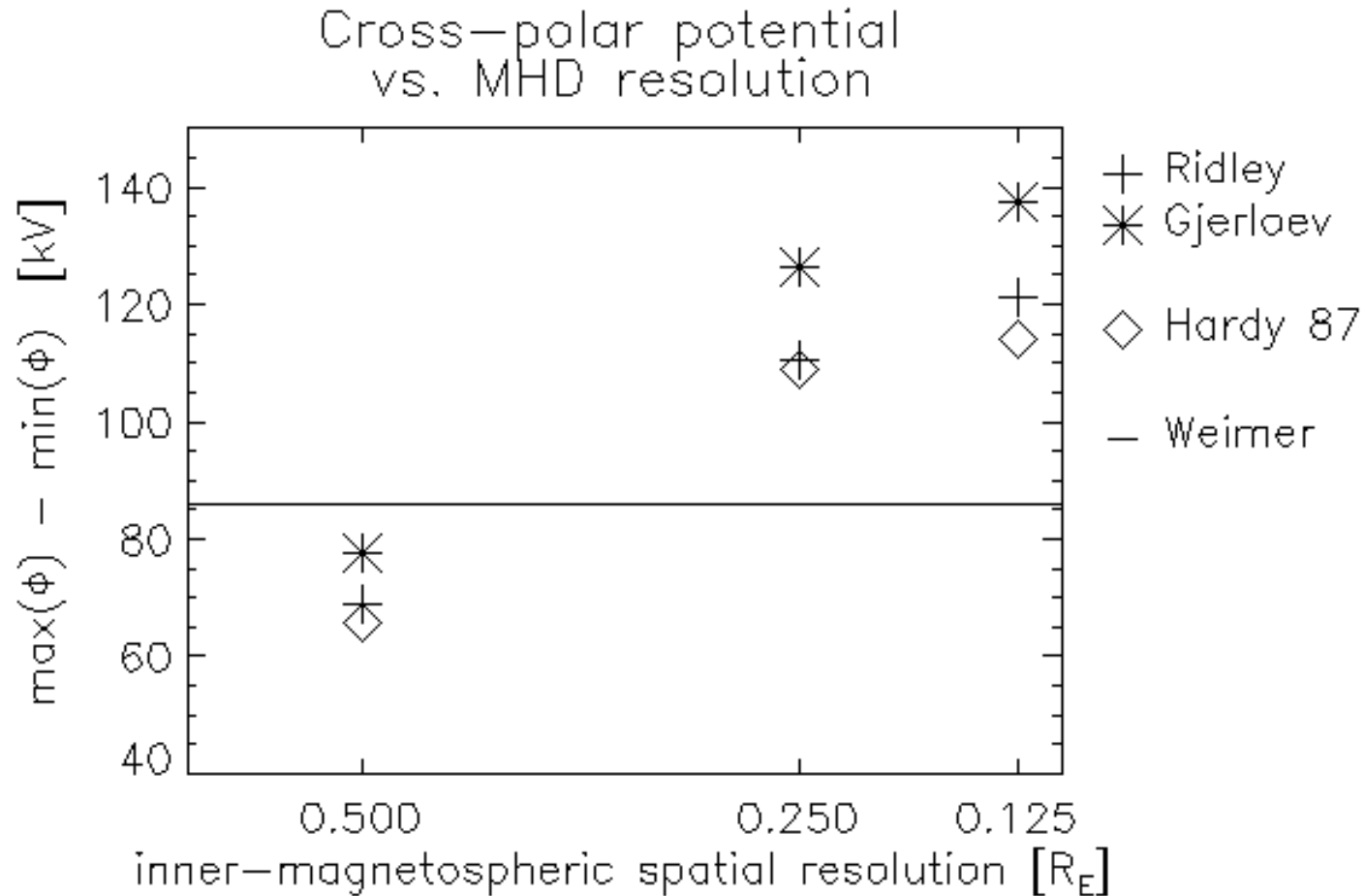
- electric potentials with same model / conductance
- field-aligned currents (minimum, maximum, integrated)

# 1) Conductance model affects potential



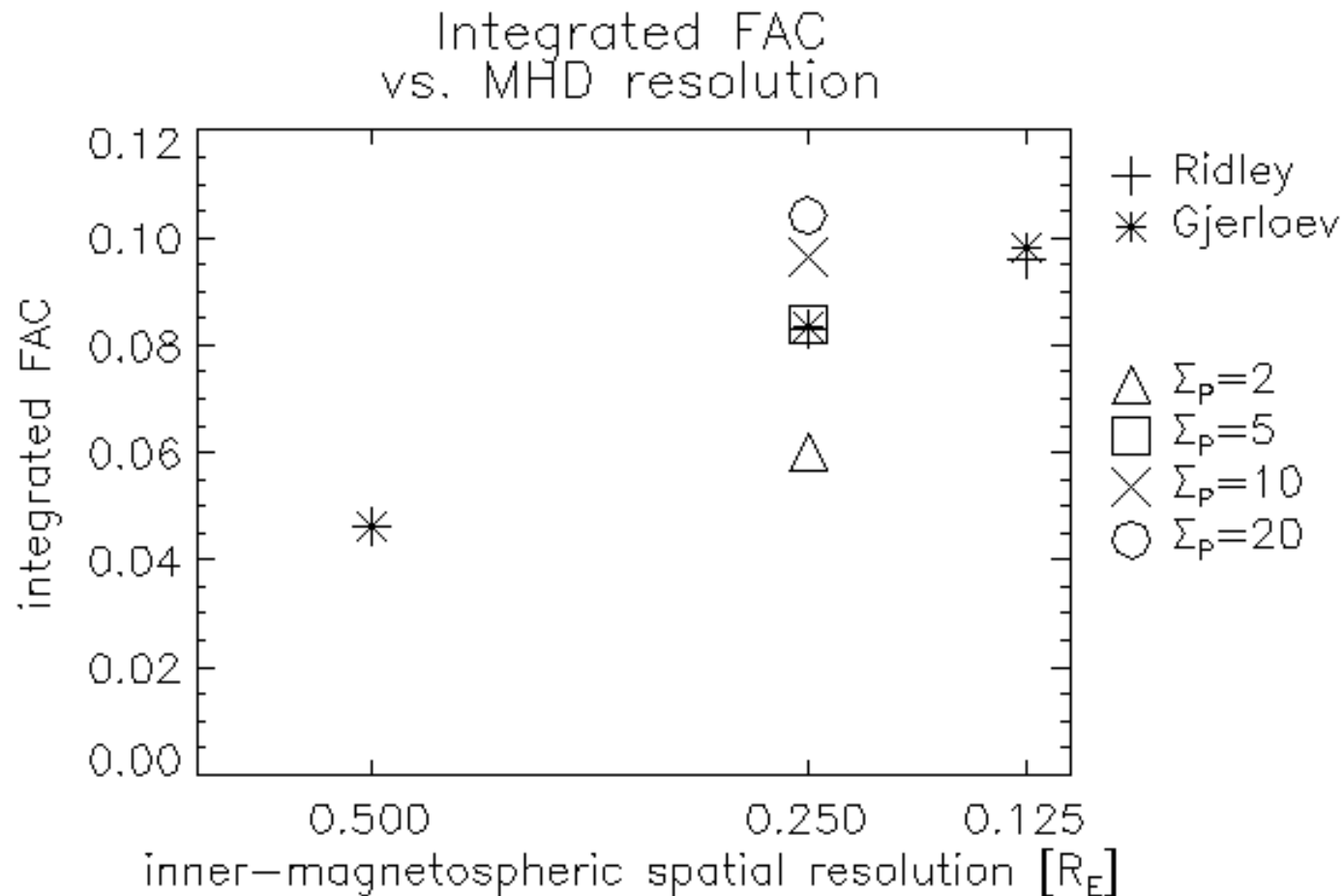
no-surprise here, of course  $\square$

## 2) Spatial resolution study



Why do **potentials increase** with **better resolution**?

# MHD resolution affect currents



**(!):** Integrated currents increase with better MHD resolution.

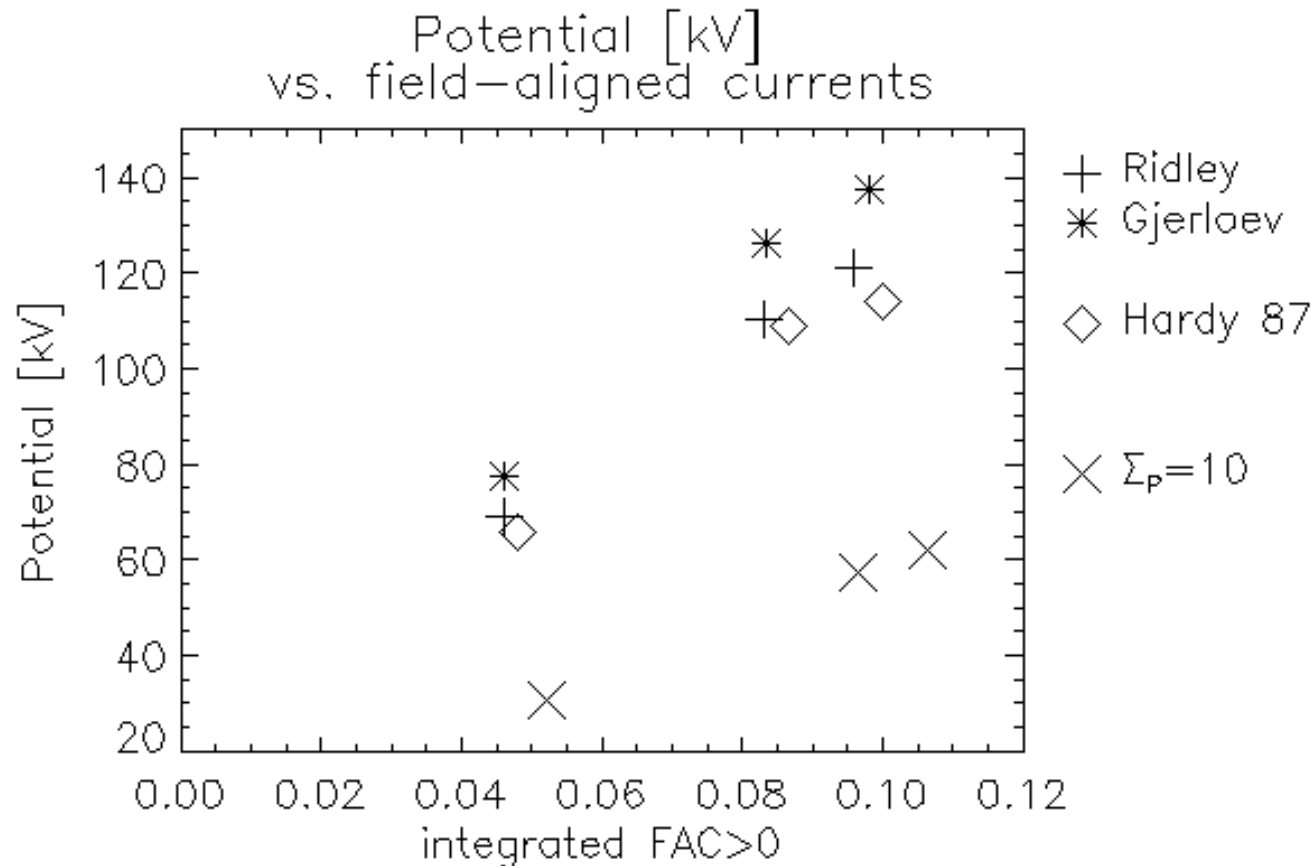
**No surprise:** Currents increase also with higher conductance.

# Conclusions

(of resolution and conductance comparisons)

- For given conductance model, **currents increase** with **better MHD resolution**.
- **Currents increase** with **higher conductance**
  - this is a feedback effect influencing the inner magnetosphere.

# Dependence of potential on currents



**FAC** are determined by **MHD resolution** (as shown before).

**FAC-dependent** models (Ridley, Gjerloev, in polar cap) show weaker increase than **fixed-conductance** models (Hardy, 10-mho).

# Feedback?

- **Current-dependent** models tend to **increase potentials** compared to **fixed-conductance** models with **same average conductance**

**Cause:** **currents** into the ionosphere lead to **higher conductances** to create **positive feedback**.

- **Higher overall conductances** **reduce potentials** by overcompensating the increased currents drawn into the ionosphere.

# Conclusions

- low-resolution BATSRUS runs seem to fare as well as statistical potential models (Weimer □2K)
- Increasing MHD resolution does not necessarily improve performance (potentials can be overestimated)
  - MHD resolution at about  $1/3 R_E$  comparable with statistical model
  - 2000 GEM Metric challenge run performed at CCMC yielded highest skill score at  $1/2 R_E$  resolution (without changing other parameters).
- Higher currents for high resolution simulations indicate more efficient feedback between ionosphere and magnetosphere.

## Outlook:

- Develop Gjerloev model to account for varying spatial resolution of the MHD model
- Compare BATSRUS results with other MHD models
  - UCLA-GGCM with CTIM shows higher currents and uses higher conductances to arrive at similar potentials

# Gjerloev model

## Goal:

Generate **resolution-independent** ionospheric potentials

## Method:

Use DE-2 data (statistical model similar to Ridley, Hardy 87)

Use **spatially averaged FAC** to enter statistical FAC-conductance relationship.

- **Width of averaging window** can account for expected scale of **FAC from MHD simulation**:
- **Increase feedback** between FAC and conductances to **draw more current at low MHD resolution**.
- **Reduce feedback** to **draw less current at high resolution**.